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ABSTRACT

This report focuses on the user of a prototype hypertext application designed to help coin collectors link ancient coins with relevant numismatic information. It is noted that hypertext systems promote the collection of information that may be multimedia in nature and may be linked so that information can be accessed in a non-linear manner. The prototype is a hypertext environment that uses an expert system and a word processor to provide access to information resources such as databases of text, images, and graphics. Numismatists were chosen as the user population for the prototype system because of the variety of sources from which they compile their coin catalogs, and their ongoing need to manage large amounts of information. In order to satisfy the needs of the users, the prototype was designed so that HyperCard would provide a computer software interface to various resources. It also provides an expert system to deal with coin identification and the opening of relevant knowledge bases. The organizational model of the prototype is a table of contents listing the databases available for use. Users choose a database as a starting point, and then link to the other databases through HyperCard applications, depending on the information they require. The report includes a description of HyperCard as well as a list of the databases used in the prototype. (21 references) (DB)

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Judi Moline

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Linking Information to Objects: A Hypertext Prototype for Numismatists

by Judi Moline

Recent developments in computer technology have created new ways to create, collect, store, retrieve, and disseminate information. One of these ways is with hypertext.[1] Hypertext systems promote the collection of information which may be multi-media and which may be linked so that it can be accessed in a non-linear manner; that is, the user jumps around the information base at will. It has been shown that electronic searches of hypertext are more efficient than manual searches.[2]

The present study focuses on the user of a prototype hypertext application designed to link ancient coins with the plethora of information about them. The model on which this prototype is based was developed to explore the possibilities of linking art objects with their related information (Moline 1989). The prototype consists of a hypertext environment which provides access to the information resources and tools needed by the numismatist. The information resources include "information bases" of text, images, graphics, or compound material. The tools include an expert system and a word processor.

In order to measure the effectiveness of the prototype, a specific user community was chosen. Because of the author's interest and research in Arab numismatics of the Umayyad dynasty, the databases are limited to information concerning this field. The potential users are numismatists, historians, museum curators, historical economists, historical anthropologists and sociologists.

A limited collection of coins and related information has been entered into the prototype system and it will be used to resolve information queries. These uses will be documented and analyzed to determine whether or not the user is able to resolve his/her need for information. Care will be taken in

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the collection of data to record the user's steps in learning the system, as well as the user's frustration or problems with the interface.

The basic reason for the development of this hypertext prototype is to provide a model for many areas of information management, as well as to serve the needs of the numismatist. In fact, it is expected that it will be useful to a variety of researchers besides the numismatist, for example, historians, archaeologists, and museum curators.

The data in the information and knowledge bases aid the coin collector in identifying coins of a specific dynasty and geographical region. If this prototype were to serve as a model for a series of resources covering different numismatic collections and if the information were made available to the research community, the fields that use the findings generated by numismatists would be enhanced. For example, motifs used on coins might be more easily traced to other art forms such as metalwork, paintings, and architecture. Further, economic history research could incorporate data generated from the study of the coins of the period.

USER REQUIREMENTS: RESOURCES OF THE NUMISMATIST

Coin collectors, dealers, and scholars have large databases itemizing their collections. These databases may be computer-based or card-based and may include records of coins held by the individual or those of interest to an area of research. Each record contains fields of information. The number of fields per record may range from fewer than 20 to almost 50. Preliminary research done by this author[3] showed that there was little agreement about which fields are crucial except for the two selected by all 9 respondents. These two fields were weight and denomination of the coin. Eight respondents reported using the same six fields (denomination, date of object, mint where issued, catalogue reference, reverse type or image, and weight) while seven reported using the same 10 fields (denomination, date of object, place where found or acquired, dimension, mint, obverse type or image, person named on object, catalogue reference, reverse type or image, and weight). The fields used by each researcher are usually in a prescribed order and involve the use of a predetermined vocabulary. Each researcher achieves consistency in format and vocabulary only by rigid adherence to a scheme designed in advance of record entry. To date, uniformity and standardization among collections have not been a major concern.

In order to compile their coin catalogues, numismatists consult a variety of sources. First, there is usually a standard reference for the particular type of coin against which coins are compared. This reference provides a number

for each coin face. The reference for the obverse (front of the coin, or "head" in U.S. coins) is not necessarily the same for the reverse. The standard reference might be the catalogue of a comprehensive collection or it might be a compilation of many collections with reference numbers unique to the publication. In addition to the standard reference, other coin catalogues are also necessary. The researcher dealing with unique or rare specimens wants to have as much information as possible about all coins under study.

By matching details of the coins, a coin can be identified. For the majority of identification problems, simple matching is adequate. Identification usually includes a type, description, historical context, and references. For other research questions, the numismatist consults a variety of sources. For example, other resources are needed to relate named individuals with their period in history, to locate mints, to discuss minting customs and economic policy of the period, and to identify similar or identical objects. Besides coin catalogues or other coin inventories, the numismatist consults histories, archaeological reports, anthropological and sociological studies, numismatics research articles, political treatises, art histories, metallurgy references, and photographs. These materials may be contemporary with the coin or studies made between the time of the coin and today. Further, the numismatist depends on experts to help with coins from outside his/her area of expertise. Figure 1 shows the primary and secondary resources used by numismatists.

PROTOTYPE APPLICATION

Hypertext encourages non-linear writing and provides a user friendly interface. Many research areas require the use of standard reference works, as well as a wide variety of other materials. Numismatic research is no different. The researcher must be able to visualize a variety of coins and compare the details to other coins and perhaps to other art forms. The details go beyond iconography and calligraphy to include physical factors such as the quality of the die from which the coin was made, the quality of the strike, and the metallurgy of coins. Further, the numismatist must relate these objects (and the assorted details) to catalogue entries, historical events, places, personalities, and economic conditions of the period.

The hypertext prototype for numismatists integrates tools and information bases needed by researchers in numismatics (see Figure 2). With this application, the numismatic researcher may retrieve specific linked information by simply activating a button on the screen. These buttons may be either visible or hidden. The visible buttons are in the form of icons while

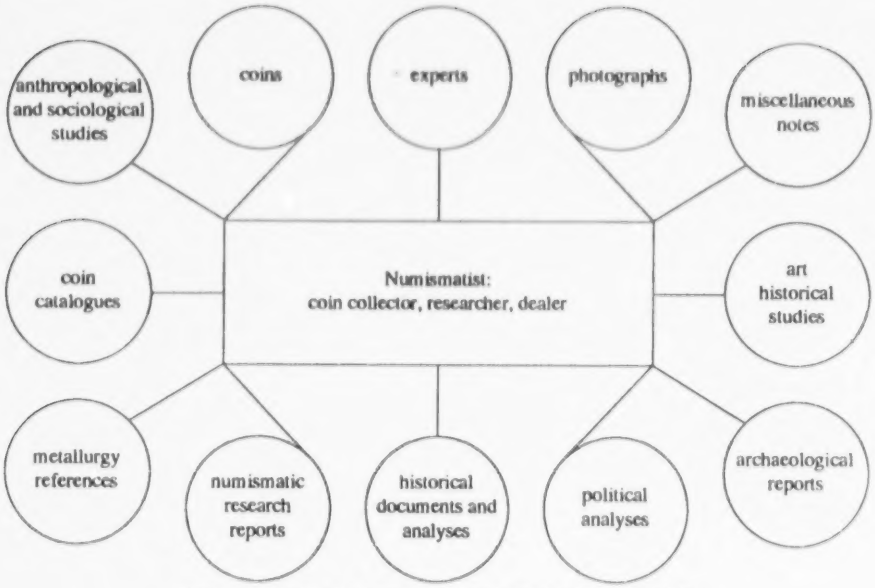


Figure 1. Model of Informational Requirements of Numismatists.

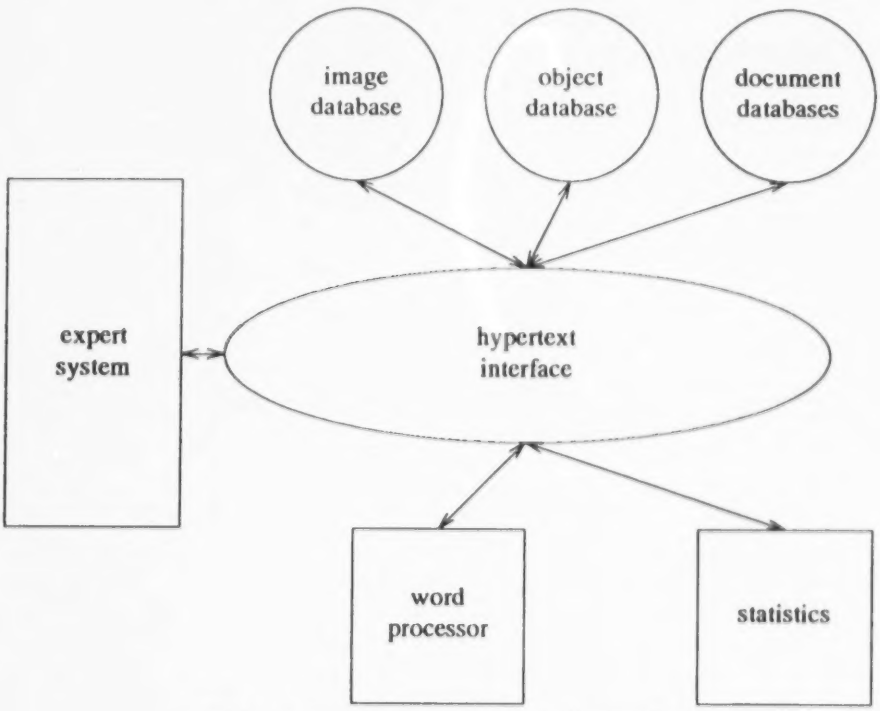
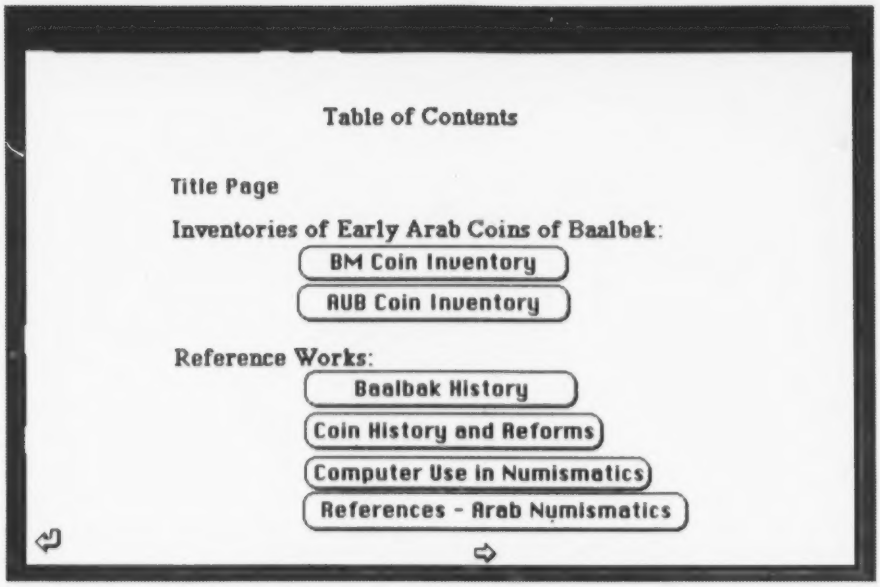
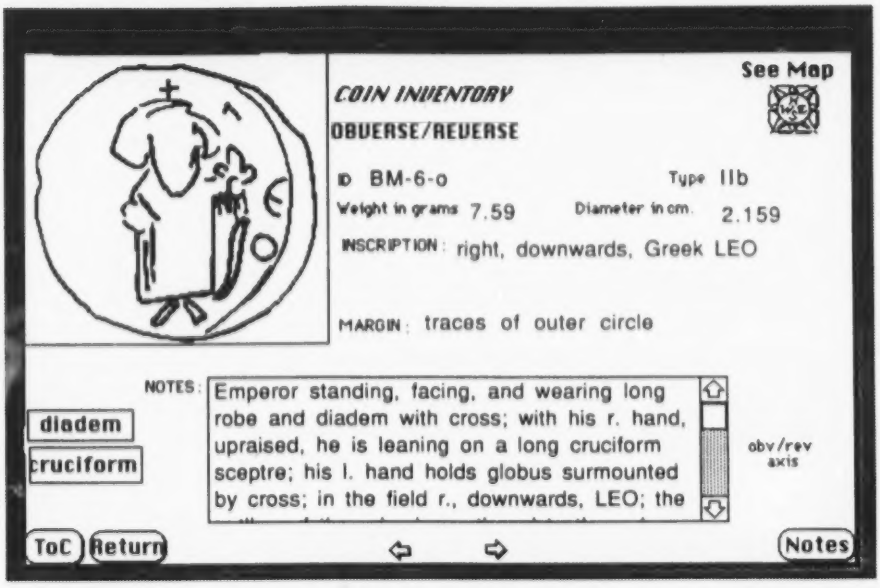


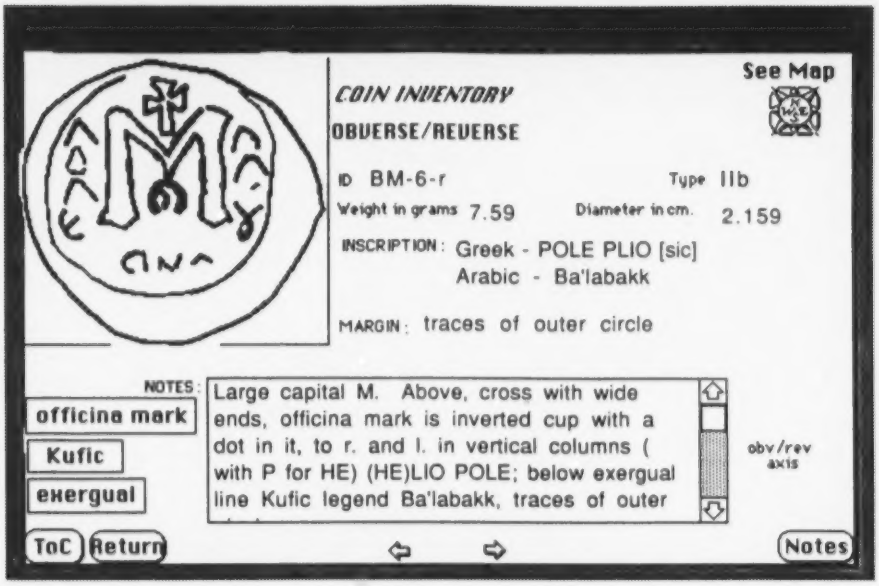
Figure 2. Model of Application Prototype for Numismatists.



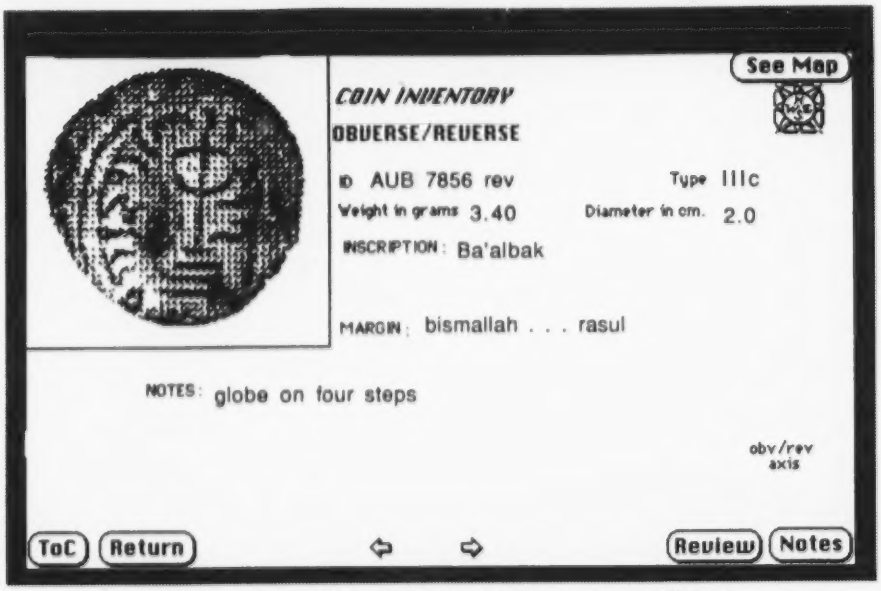
Screen 1. Table of Contents of the Hypertext Prototype, page 1.


See Map
COIN INVENTORY
OBVERSE/REVERSE
ID BM-6-o
Type IIb
Weight in grams 7.59
Diameter in cm. 2.159
INSCRIPTION: right, downwards, Greek LEO
MARGIN: traces of outer circle
NOTES:
Emperor standing, facing, and wearing long robe and diadem with cross; with his r. hand, upraised, he is leaning on a long cruciform sceptre; his l. hand holds globus surmounted by cross; in the field r., downwards, LEO; the
diadem
cruciform
obv/rev axis
ToC
Return
Notes

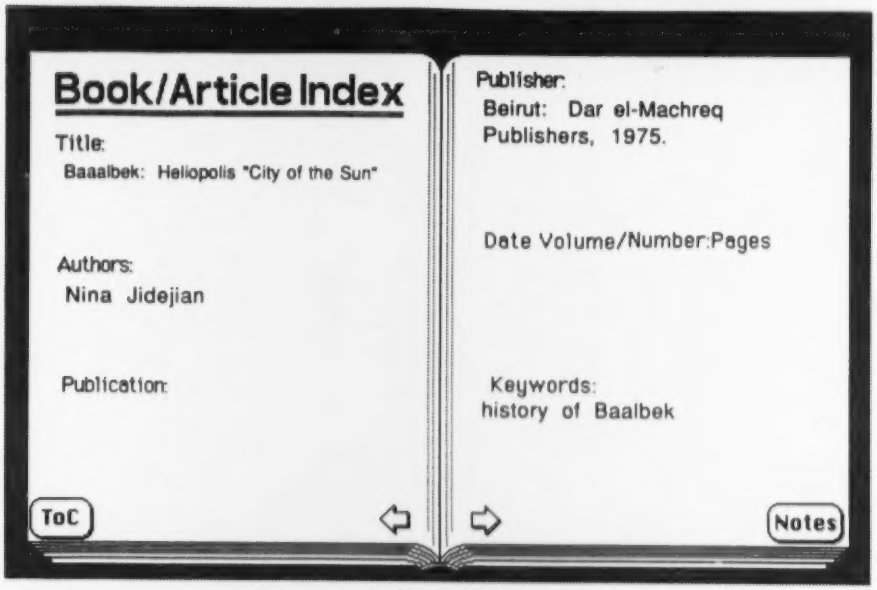
Screen 2. British Museum Coin Inventory, obverse.


See Map
COIN INVENTORY
OBVERSE/REVERSE
ID BM-6-r
Type IIb
Weight in grams 7.59
Diameter in cm. 2.159
INSCRIPTION: Greek - POLE PLIO [sic]
Arabic - Ba'labakk
MARGIN: traces of outer circle
NOTES:
officina mark
Kufic
exergual
Large capital M. Above, cross with wide ends, officina mark is inverted cup with a dot in it, to r. and l. in vertical columns (with P for HE) (HE)LIO POLE; below exergual line Kufic legend Ba'labakk, traces of outer
obv/rev axis
ToC
Return
Notes

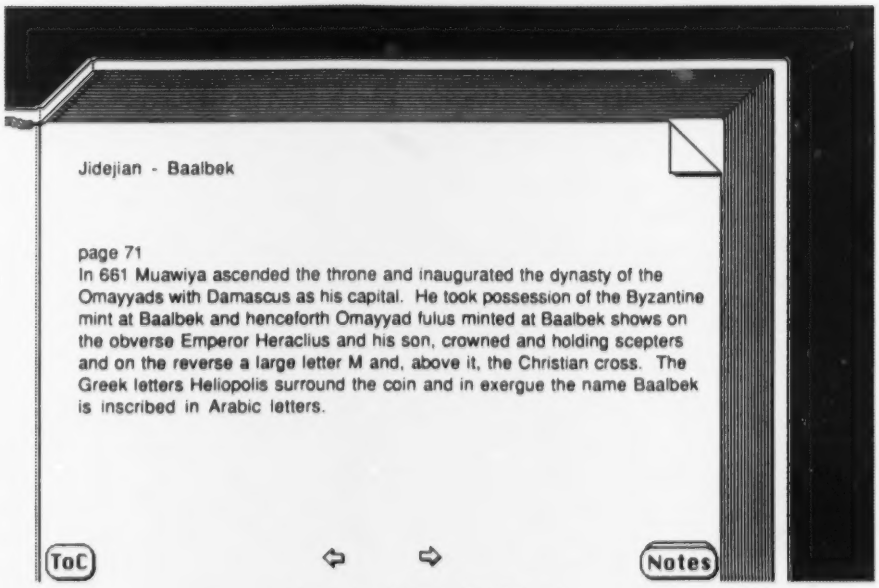
Screen 3. British Museum Coin Inventory, reverse.



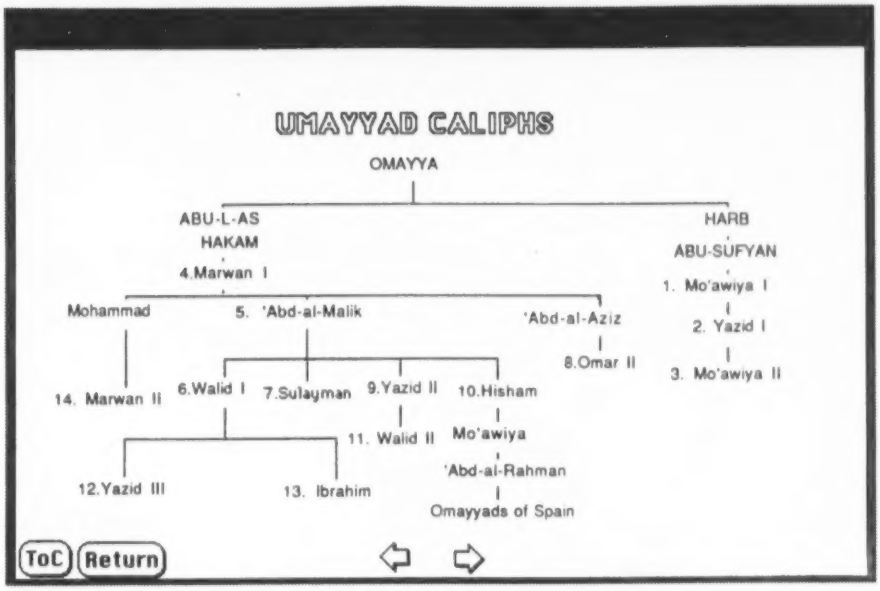
Screen 4. American University of Beirut Coin Inventory, scanned image.



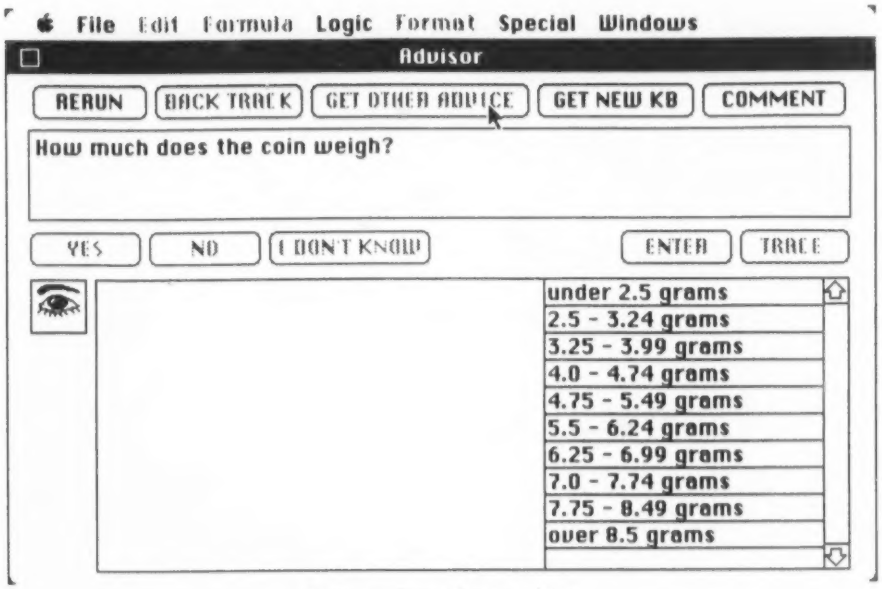
Screen 5. History of Baalbek, reference.


Jidejian - Baalbek
page 71
In 661 Muawiya ascended the throne and inaugurated the dynasty of the Omayyads with Damascus as his capital. He took possession of the Byzantine mint at Baalbek and henceforth Omayyad fulus minted at Baalbek shows on the obverse Emperor Heraclius and his son, crowned and holding scepters and on the reverse a large letter M and, above it, the Christian cross. The Greek letters Heliopolis surround the coin and in exergue the name Baalbek is inscribed in Arabic letters.
ToC
Notes

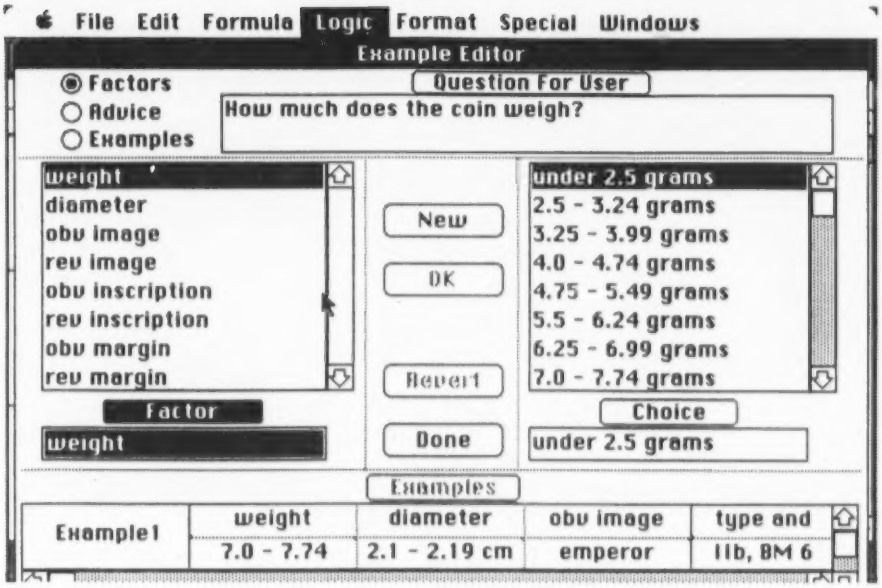
Screen 6. History of Baalbek, text.



Screen 7. Genealogy, final screen.



Screen 8. Expert System, advisor.



Screen 9. Expert System, set-up.

the hidden links are transparent buttons placed over words in the text or components of an image. The hidden buttons become visible when the cursor is passed over them. Although studies have not yet shown that visible buttons interfere with the comprehension of a screen of data, a button over text would be disruptive. With invisible buttons a user wanting more information regarding a term or an image, can easily ascertain if there is linked information. The alternative search mechanisms needed to locate material not previously linked are not so straightforward as they might be and may involve browsing.

In this prototype, browsing is kept relatively simple because materials have been grouped according to the source of the information. For example, all images have been put together in one stack, all inventory "cards" have been put in another, all information on the history of Baalbek is in a third stack, and so on. Thus, the resources appear to be very close to their paper counterparts in organization. However, due to the linking mechanism, one may jump back and forth between information bases seamlessly. To do this with traditional materials, one would need a large table where all the different books, catalogues, and journals could be within arm's reach with all relevant passages flagged. In addition to printed material, the researcher would need inventory cards or lists and photographs or schematic drawings

within easy reach. Finally, the researcher would need some non-print tools: an expert, scientific calculator with appropriate functions, and a word processor or typewriter.

THE COMPUTER SOFTWARE

Although the prototype has extensive textual content, the efficiency and effectiveness of the prototype depend on the variety of the resources and tools which have been linked together. Purists argue that HyperCard™[4] is not a hypertext system; however, it facilitates the development of a hypertext and provides the functions necessary for the present prototype.

An important part of this prototype is the variety of information types which must be logically structured and linked. The matching of an image in the system with an object is only the first step in identifying an object where small differences are often overlooked. The user may opt for browsing a stack of items similar to the one at hand in order to match the details, or may opt for advice from the expert system. (See the sample screens accompanying this paper.) MacSMARTS™, an expert system shell, is launched from within HyperCard™. When a user needs help in identifying an object and selects the "Advice" button on the screen, he/she is linked with the knowledge base which deals with similar coin faces. A series of questions is asked by the "expert" to ascertain which of the coin records contained in the coin inventory is most like the coin being described.

If responses to questions posed by the expert system indicate that the coin is like one in the coin inventory, the user is advised to compare the coin detail by detail with the description contained on the inventory card for the related coin.[5] On the other hand, if the expert system is unable to reach a satisfactory conclusion based on data provided, the user is returned to the image stack for further matching.

SATISFYING THE INFORMATIONAL NEEDS OF THE NUMISMATIST

In order to satisfy the needs of the potential users, the prototype was designed so that HyperCard™ would provide a user interface to various resources. There are many other software packages which could have been used.

To deal with coin identification, the prototype provides an expert system. The user of the hypertext prototype identifies a general coin type from illustrations or coin inventories, and the system opens the relevant knowl-

edge base. The user then responds to the questions until a conclusion for the query is reached. Depending on how much work has gone into developing the particular knowledge base, the user is given classification information for the coin. In the case of coins minted at Baalbek by the Umayyads, the reference suggests a particular face type as published in the catalogue of the British Museum. If the coin is from one of the neighboring mints, the user is advised of its particular type; and if a mint has been ascertained, this information is also provided.

The final component of the prototype application is the word processor. When the "Notes" button is selected, a file is opened which serves as a note pad by the user (See Figure 2 for the components of the prototype application).

CONTENTS AND ORGANIZATION OF THE INFORMATION IN THE HYPERTEXT PROTOTYPE

The basic organizational model of this hypertext prototype is that of a table of contents of a typical book. The table of contents lists the databases which are available for use. Once the user chooses a "chapter" or database, he/she may return to the table of contents or go to any of the other linked databases. Because several different databases are used in the prototype described in this paper, these databases are referred to as object bases, image bases, or document bases depending on the nature of their contents.

The components of the present prototype include the following databases or stacks accessible from the table of contents: BM Coin Inventory, AUB Coin Inventory, Baalbek History, Coin History and Reforms, Computer Use in Numismatics, References—Arab Numismatics, Dictionary—Arabic/English, Genealogy, Glossary, Index, and Maps. In addition, Help and Advice are available from the title page. These are explained in the following paragraphs.

BM Coin Inventory. The BM Coin Inventory stack includes the Umayyad coins minted in Baalbek which have been published in the catalogue of the British Museum (Walker 1956). This stack provides the basic set of coins against which others are compared. Each record in this stack contains one image field and eight text fields. The text fields are ID Number, Coin Type, Weight in grams, Diameter in centimeters, Field inscription, Margin contents, Notes describing the coin face (a scrolling field), and Obverse/Reverse axis. The number of buttons per card varies but there are six buttons which are uniform throughout the stack: ToC (Table of Contents), Return, Back Arrow, Forward Arrow, Notes, and See Map. In addition to the uniform set

of buttons, parts of the image, Arabic terms or names, proper nouns, and unusual terms are linked to clarification screens with hidden buttons. The hidden buttons become visible when the cursor is passed over them.

AUB Coin Inventory. This stack contains records of coins in the American University of Beirut Museum. The records contain the same fields as those of the "BM Coin Inventory" stack.

Baalbek History. This set of records has two formats. One is in the shape of an open book and contains six fields giving the bibliographic information about the books or articles that are included. The second is designed to emulate the page of an open book and has two fields, a small one at the top for the source identification (author and title) and an area for text limited in size to a paragraph.

The same format used in the "Baalbek History" stack is followed for the other Reference Works databases, i.e., Coin History and Reforms, Computer Use in Numismatics, and References—Arab Numismatics.

Dictionary—Arabic/English. The Arabic/English Dictionary has two fields, one for the Arabic word and one for the meaning.

Genealogy. The Genealogy stack is a tree-like diagram that is filled in as the user flips through the stack. It provides the names and sequence for the Umayyad Caliphs.

Glossary. This stack is in the same format as the Arabic/English Dictionary.

Index. The index stack provides an alphabetical listing of terms linked to a point in the system.

Maps. The stack of Maps contains images of maps.

Help. The introduction or help screen can be accessed only from the Title Page. This stack is a single screen and provides encouragement to the user and brief "how to" instructions.

Advice. The Advice button provides access to the expert system. The button first takes the user to a stack of coin images. These images are linked to knowledge bases dealing with particular types of coins.

LINKS USED IN THE PROTOTYPE

The challenge for hypertext designers is to understand the user's task, and to support links that follow from some model of the user's need for information in some particular context (Glushko 1989a, 297).

In order to appreciate the value of links in hypertext, one must first consider the way that the resources or information would be accessed in a traditional research setting. For the numismatist doing research, a collec-

tion of historical documentation, coin catalogues, maps, and genealogies would be necessary. The researcher would then search through them looking for clues which would help resolve the informational need. Tables of contents, indices, chapter titles and subtitles, illustrations, tables, figures, and footnotes would all be taken into consideration. These features of paper documents provide access to the information contained in the documents (see Table 1).

If these same historical documents and other information resources were available in electronic form, the user would need access capabilities designed to take into account his/her informational needs. The system would traditionally involve querying an index. An alternative to this traditional searching would be to use hypertext capabilities. Hypertext offers the ability to link databases, records, or specific fields to other databases, records, or fields. The same item may be linked multiple times to a variety of destinations, if necessary. The determining factor in linking the components of a hypertext is the anticipated needs of the users. The links are generated to connect logically information that may be physically disparate. The user moves from one screen to another without considering in which database he/she is currently working. This means, for example, that information contained in a dictionary could be linked directly to a word in a textual passage or that a map could be brought up on the screen when the user encounters a geographical place name that is unfamiliar. The links can be automatically triggered or, more commonly, triggered by the user. Linking allows for great flexibility in structuring the material.

Table 1. Links Found in Paper Documents

	Explicit Links in Paper Documents	Implicit Links in Paper Documents
Intradocument links	Links which explicitly connect two parts of a single document: Footnotes, see also, cross-references, pointers to figures, illustrations, non-text.	Links which are part of the logical structure which are implied: Reverse of 'see also,' i.e., cited by, terms in text which are defined in Glossary
Interdocument links	Links which explicitly connect at least two parts of at least two documents: Cited references	Links which are not explicit between related documents which could be extracted by careful and creative analysis of texts and relationships between them.

After Glushko, 1989b.

The prototype contains information that would normally be available in a variety of resources and forms. That this information is assembled in a single computer application is significant. However, the real value is in the links which have been created. The links were made to facilitate the work of the numismatist doing research on early Arab coins. Although the collection of resources in the application are relevant to a variety of researchers, the links within and among the resources were designed to meet the unique needs of the numismatist. This is not to say that others would not benefit from the work. However, they might want to personalize the application for their needs by adding links.

Visible and hidden links have been used in this prototype. These links connect information between databases or within a single database. The inner-database opaque buttons link the table of contents to the appropriate databases, the relevant map to the current card, and the special terms to the glossary. The inter-database hidden buttons link components of images and terms to the Arabic-English dictionary or to the glossary. The bent arrow or return button is visible and allows the user to return to the previous screen whether or not it is in the same database as the current screen. It is therefore an inter- or an intra-database link. The intra-database visible buttons allow the user to move screen by screen in the current database (whether forward or backward). Further, materials within the database are linked with hidden links. These are used primarily for footnotes or references. The links in the prototype are summarized in Table 2.

FUTURE WORK

There is still much work to be done to show that this prototype is useful in the real world. First, the suitability for users of this prototype system must be tested. Then content must be added to make it useful to the general collector of coins, and additional content is necessary to determine if the

Table 2. Links Used in the Prototype

	Visible Links Opaque Buttons	Hidden Links Transparent Buttons
Interdatabase	TOC	Portions of image
	Vocabulary items	Terms in context
	Maps	
Inter-/Intradatabase	Bent arrow or return	
Intradatabase	Screen forward	Footnote
	Screen back	

prototype can be scaled up. How many "stacks" of how many "cards" can be introduced before the system grinds to a halt? Likewise, how many knowledge bases can be linked together and/or to the cards in the hypertext environment before the concept of "expert advice" is eroded by the problems of generating appropriate rules and tuning them so that they work? Also, how effective are rules generated by the expert system shell from example sets?

The issue of pre- versus post-coordinated links also needs to be considered. With large information bases, serendipity plays an important but unpredictable role. Careful design of the links must be made before too much data are entered. The designer of the prototype must have a clear understanding of the needs of the user community and must work closely with that group in order to be sure that the needs are being met.

Even more important than the previous is the need to determine if the system serves the user. With their permission, users will be videotaped as they use the prototype. Their searches will be analyzed in terms of their query and they will be asked to make observations about their objectives and how the system assisted or hindered their work. Analysis will include all aspects of system design.

The prototype facilitates the categorization of Arab coins. It would seem easier to interact with the computer than to sort through catalogues trying to match images or descriptions. The expert system environment of the prototype emulates working with an expert to identify a coin. An alternative to this, the hypertext environment, is also available. Hypertext allows "browsing" so that, for example, a user could identify a coin type and then browse the stack to look at other coins of the same type.

The prototype application combines hypertext with limited artificial intelligence in the form of an expert system. It was designed with a specific user community in mind. It is now necessary to ascertain whether or not it meets the needs of the researchers in the field of early Arabic numismatics. Further, it is important to determine what features need to be added to meet the needs of other researchers in the museum community.

NOTES

1. Hypertext was recently defined at the Hypertext Standardization Workshop: A *Hypertext* is a network of information nodes connected by means of relational links. A *Hypertext System* is a configuration of hardware and software that presents a Hypertext to users and allows them to manage and access the information that it contains (Moline 1990, 10).

2. For example, the comparison of the hypertext browser "SuperBook" with the conventional printed book showed those using hypertext did better when they knew the author's words. Basically, the researchers credited the success of SuperBook with a thorough table of contents and index (Egan 1989).

3. A survey was distributed to a group of 12 serious coin collectors. Nine responded immediately. Six of the respondents used the same 18 fields, five the same 19, four the same 24, three the same 30, two the same 39, and one individual used 43 fields. A list of 52 possible fields was taken from the "Islamic Manual" used in 1983 by the American Numismatics Society (New York City). Individuals were asked to indicate which of the fields they used. Since terminology can vary, providing a controlled vocabulary was the only way to obtain comparative data. However, there is still the likelihood that interpretation of the terms may have played a role among the individuals surveyed. Further work is needed on the vocabulary of numismatics.

4. Certain commercial products are identified in this paper in order to specify adequately the procedures being described. In no case does such identification imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the material identified is necessarily the best for the purpose.

5. The collection of the British Museum (Walker 1956, 5, 12–14, 32, 236–239) is used as the reference for this prototype. There are 28 coins with one showing the emperor standing, nine coins showing the emperor and his son standing, two coins showing the caliph standing, and 16 coins in the post-reform type. The author has references for a total of 118 coins (one of the emperor standing, 39 of the emperor and son, seven of the caliph, and 71 post-reform). The additional 90 coins were used as needed to simulate user input.

SELECTED REFERENCES

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